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ABSTRACT

Recent research projects demonstrate that pictures in reading textbooks have a negative effect on the word-decoding ability of young readers. This particular study questioned whether the relative difficulty of the words being read determines the effect that pictures have on good, normal, and poor readers. After pretesting to determine reading level, third grade students were asked to read easy, moderate, and difficult one-syllable nouns under each of three conditions: a control condition with no pictures, an identifying picture condition, and an unrelated picture situation. The results indicated that the reading performance of poor readers, as a group, was influenced by pictures under all conditions, while that of normal and good readers was considerably less affected by pictures. There were, in addition, marked individual differences in the degree of susceptibility to distraction among the poor readers. (MAI)

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Individual Differences in Distraction by Pictures in a Reading Situation

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Abstract

This research was designed to determine whether the relative difficulty of the words being read influences the extent to which good, normal, and poor readers' decoding is susceptible to influence by adjunct pictures. Third graders were required tc read easy, moderate, and difficult one-syllable nouns under each of three conditions: a control condition with no pictures, an identifying-picture condition, and an unrelated-picture condition. The results showed that the reading performance of poor readers as a group was influenced by pictures under all conditions, while that of normal and good readers was much less affected by them. There were, however, marked individual differences among the poor readers in the degree of their susceptibility to distraction.

Individual Differences in Distraction by Pictures in a Reading Situation

For many years illustrations have been included in the primers used for teaching reading on the assumption that pictures facilitate children's acquisition of reading skill (Huey, 1908/1968). The amount and salience of the artwork in children's readers and other school books has increased drastically in the past decade. Thus far, however, few researchers have asked, "Does all of this artwork help in the business of learning to read?" (Gibson & Levin, 1975; Samuels, 1970).

On the basis of some recent work examining the effect of pictures on decoding (Willows, 1978), there is some suggestion that, where learning to read is concerned, a picture may not always be worth a thousand words. In a series of two studies Willows (1978) demonstrated that when children in second and third grade read a set of familiar words, their performance was less efficient in terms of both time and errors if there were pictures in peripheral vision. An additional finding was that the interference caused by pictures was greater for less skilled readers. Although Willows' research clearly demonstrated that pictures interfered with reading performance on her task, the fact that the extent of the interference was inversely related to reading ability is amenable to more than one interpretation:

(a) It may be that there are individual differences among children in susceptibility to visual distraction while they are reading. Individuals who are particularly susceptible to distraction by information in peripheral vision may become poor readers as a direct result of their distractibility. (b) On the other hand, whether or not pictures are distracting in a given situation may simply be a function of the relative difficulty of the particular reading materials for each individual. Although the words in both of Willows' studies were decoded with a high degree of accuracy by all children, the attentional requirement of decoding the words may have been quite different for children at different levels of reading skill. According to a recent theory of automatic information processing in reading (LaBerge & Samuels, 1974), decoding of a set of words can, with practice, become automatized such that word recognition can occur without attention. When any individual is required to read a set of words he has already automatized, he may be able to process extraneous pictorial information simultaneously with no performance decrement on the decoding task. In Willows' study, the more skilled readers may have been decoding the words automatically, while for the less skilled readers, decoding the same set of words may have required the services of attention.

If the former interpretation of Willows' results is correct, then children who are distracted by pictures while

reading a difficult set of words would also suffer interference while reading words which are considerably easier for them. If the latter interpretation is more accurate, then children's decoding should be little affected by pictures in the periphery when the words they are reading are easy for them, and their performance should be vulnerable to distraction when they are decoding words which are more difficult for them. The present research was designed to determine which of these two alternative interpretations provides a better explanation of the results of the earlier studies.

There were three phases in this research. In the first, children were group-tested in their classrooms on standardized tests of reading comprehension and non-verbal intelligence. In the second phase, the difficulty level of a large number of nouns was assessed by presenting them individually to each child and recording reaction times and errors. Finally, in the third phase, words ranked as easy, moderate, and difficult on the basis of reaction-time data, were presented alone and in two picture-word conditions to children of good, normal, and poor reading ability.

Phase 1

This initial phase simply involved the group testing of a large sample of children on standardized tests of reading achievement and intelligence.

Method

Subjects. Letters requesting participation in a study of "factors which influence reading" were sent home with all of the children in five third-grade classrooms located in three middle-class parochial schools. All of the 91 children (48 boys and 43 girls) whose parents consented were included in this initial phase of the study.

Procedure. Each classroom of children was group-tested on standardized tests of reading achievement and IQ on two consecutive days. On the first group-testing day, Form A (Scale 2) of the IPAT Culture Fair Intelligence Test (Cattell & Cattell, 1960) was administered, followed by the Comprehension subtest of Form 1 (Survey C) of the Gates-MacGinitie Reading Tests (Gates & MacGinitie, 1965). On the second group-testing day, Form B (Scale 2) of the IPAT Culture Fair Intelligence Test was administered followed by the Comprehension subtest of Form 2 (Survey C) of the Gates-MacGinitie Reading Tests. All of the standardized tests were administered by the same female experimenter, an experienced classroom teacher, who also conducted the individual testing for the picture-word task. Both tests were scored according to the instructions in the manuals. The reading comprehension raw scores were converted to standard scores using the tables which accompanied the test. Mean IQ and reading comprehension scores were calculated by averaging the two scores obtained by each child.

Phase 2

The objective of this phase of the study was to obtain a set of words which could be decoded with a high degree of accuracy by both good and poor readers but which would include a range of difficulty.

Method

Subjects. The data from 74 children were included in this phase. The children who participated in the first phase but whose data were not included in the second phase were four children who did not speak English as their first language, eight children who were absent on one or more testing day in Phase 1 or 2, and five children who were so deficient in their decoding skills that they could not complete the Phase-2 task.

Procedure. The word lists accompanying the reading series used in the three schools were consulted to select a set of 160 first- and second-grade nouns with which all of the third graders should have been familiar. Each of these nouns was printed in primary type and photographed. The resulting slides were randomly assigned to five groups of 32 slides each. The order of presentation of these five sets of words was counterbalanced across subjects. The children were tested individually in a small quiet room in the school. Each slide was presented individually on a rear-view projection screen three feet (.91m) from the child. From that viewing distance, the words were easily readable

and appeared a little larger than the print the children were used to seeing in their readers at school. The instructions were simply to read each word as soon as it came onto the screen. The slides were presented one at a time by means of a carousel projector triggered by an automatic timer. A reaction-time key was employed to record response latency to each word. The slide remained on the screen until the child responded. After the slide had been shut off by the reaction-time key there was a five second pause, the experimenter then said "Ready?", and the next word appeared on the screen three seconds later. Between each tray of 32 slides there was a break during which the experimenter chatted with the child about topics which were unrelated to the task.

The reaction-time key was pressed by the experimenter as soon as the child started to say a word. The experimenter then recorded the child's response. Although a voice key would have been more elegant, our pilot testing indicated that more than 20% of the responses would be lost due to heavy breathing, coughing and whispered sounding out of words before actual responding. In order to be sure that the reaction time of the experimenter was a reliable measure of the child's responding, the reaction-time measure was also recorded by a second experimenter independently for the first 30 children tested. Thus there were a total of 4800 responses recorded by both experimenters. A Pearson

correlation of the two experimenters' reaction times produced a coefficient of $r = .96$. Since the reaction-time measure was found to be very reliable, all calculations were done using the scores of the principal experimenter only.

Results

The 74 children each responded to 160 words. Of their 11,840 responses, 373 were errors. The number of errors per word (out of 74) ranged from 0 to 27. Reaction times were available for the 11,467 responses which were not errors. A small proportion of these reaction times (48 of them) were markedly longer than the rest. Since even for the most difficult word, the mean reaction time was just over two seconds, a score of three seconds was arbitrarily assigned to replace the 48 extremely long reaction times. This procedure was followed to avoid inflating the mean reaction-time scores for the words on which the unrepresentative reaction times occurred.

All of the 160 words were ranked from easiest to most difficult on the basis of the mean reaction-time scores. A similar ranking was done for the decoding errors on each word. From the 160 words three subsets of 30 words each were selected as easy, moderate, and difficult to decode on the basis of the reaction-time and error scores. These words were all one-syllable nouns on which few children made decoding errors. In Table 1 the means and standard deviations of the reaction times are shown for each of the

three sets of selected words. The numbers of children (out of 74) who made decoding errors on the words are also shown.

Insert Table 1 about here

In order to determine whether these rankings were representative of children ranging in absolute reading ability, the reading achievement standard scores of the 74 children were ranked and the children were divided using a median split into good and poor readers (without regard for IQ). The mean reaction times to the 160 words were assigned ranks from shortest to longest (1-160) for the good and poor reader groups. Then, for the 90 words selected as easy, moderate, and difficult, a Pearson correlation of the ranks for good and poor readers produced a coefficient of $r(88) = .85$, $p < .01$. Although this correlation is less than perfect, it certainly indicates that, for the most part, good readers and poor readers had difficulty with the same words. The groupings of words into easy, moderate, and difficult sets were thus appropriate for all children. Although a "difficult" word was by no means equally difficult for a good and for a poor reader, the set of "difficult" words was relatively more difficult for all children than those designated "moderate" or "easy".

Phase 3

There were three goals in this major phase of the study: (1) The first was to compare the susceptibility to influence by adjunct pictures of children at three different levels of reading skill decoding a set of familiar words. (2) The second was to examine the influence of word difficulty on the extent to which adjunct pictures affect decoding. (3) The third was to ascertain whether the effects of adjunct pictures on decoding are dependent on the picture-word congruity.

Method

Subjects. For this final phase of the study, the picture-word phase, 48 children were chosen from the 74 who took part in the second phase. There were 16 good, 16 normal, and 16 poor readers (8 boys and girls in each group) selected on the basis of their reading comprehension and intelligence test scores as explained in the next section. These children did not have any known problems of vision or hearing, nor any clinical symptoms of perceptual handicap.

Selection of subjects. The test-retest reliability of the scores on the two forms of the IPAT Culture Fair Intelligence Test was $r(72) = .61$, $p < .01$, and on the two forms of the Gates-MacGinitie Comprehension tests was $r(72) = .73$, $p < .01$. A Pearson correlation of the mean reading comprehension and IQ scores yielded a coefficient of $r(72) = .46$, $p < .01$. Applying the correction for attenuation due

to the low reliability of the reading and IQ scores (Ferguson, 1971), this correlation increased to r = .69. The IPAT is entirely a non-verbal IQ test, so a correlation between reading achievement and a verbal measure of IQ would undoubtedly have been still higher.

Because measures of reading ability and IQ share a great deal of common variance (nearly 50% on the tests used here), it was deemed important to control for IQ when grouping children on reading ability. Therefore, reading ability was operationally defined in terms of both reading achievement and IQ scores. Following a method developed previously (Willows, 1974), each child's IQ score was used as a predictor of his reading potential, and his score on the reading test was taken as an index of reading performance. The size and direction of the discrepancy between predicted and obtained scores determined the assignment of children to good, normal, and poor reading groups.

Since the test-retest reliabilities on IQ and reading were not very high, all subjects whose IQ or reading comprehension scores differed by one standard deviation or more were dropped from the sample (a total of 12 children). There remained 62 children who had reliable scores on both measures. Using the scores of these children, an expected reading level for each IQ value was computed from the regression of reading achievement on IQ (following the

procedure outline by Ferguson, 1971). The discrepancy between obtained Gates-MacGinitie reading achievement and predicted reading ability based on general intelligence was calculated for every child. A child was arbitrarily designated a poor reader if his obtained reading score was at least one half of one SD below his predicted level. A good reader, on the other hand, was anyone whose reading achievement exceeded his predicted level by at least one half of one SD. For a given IQ level, then, there was at least one SD (eight points) between a good and poor reader. Anyone who obtained a discrepancy score smaller than ± 2 was designated a normal reader.

The reading ability groups thus formed differ from those in most other studies in the literature. The more usual practice is for the reading scores alone to serve as the criterion for group assignment. In this research the reading ability designation is a relative one which depends both on the reading score and on the IQ score. That is, in this research a child whose IQ is 95 and whose reading score is 50 would be considered a relatively good reader since his reading score is higher than that of most other children of similar IQ. Conversely, a child with an IQ of 120 and a reading score of 50 would be considered a relatively poor reader. Had these two individuals been assigned to reading ability groups on the basis of their reading scores alone, they would both have been assigned to the same group. When

the joint criterion of IQ and reading is employed, the resulting reading ability groups overlap to some extent in terms of absolute reading scores. They differ substantially, however, in terms of relative reading ability.

In order to insure that the groups of relatively good, normal, and poor readers were approximately equivalent in terms of age and IQ, the children in these groups were selected at random from the lists of potential subjects with the constraint that no child who was extremely discrepant in age or IQ was included in one reading ability group unless there were children with similar scores to include in the other groups. Table 2 shows the means and standard deviations of the three groups on age, IQ, and reading comprehension. There were no significant differences between the groups in age or IQ ($F < 1$). The groups did, however, differ significantly in their reading comprehension scores, $F\ (2,45) = 52.07$, $p < .01$. It should also be noted that the groups were not, as they may appear to be, substantially above average in intelligence. On the basis of the scores of more than 2000 children tested on the IPAT Culture Fair Intelligence Test in this area, the mean and standard deviation for the test are 108 and 12 respectively. Thus, the groups in this study were only slightly above average.

Insert Table 2 about here

Test Materials. Two pages of 15 words each were prepared at the three levels of word difficulty (easy, moderate, and difficult) established in Phase 2. Under the control condition, each of the resulting six pages were simply printed in lower-case primary type in three rows of five words each on 8 1/2 x 11 inch (22 x 28 cm) pages. In an identifying-picture condition, the same six sets of 15 words were used, but the order of the words on each page was randomized and one half inch (1.27 cm) above each of the words was a picture which identified it. A line drawing of a coat for example, was placed above the word "coat". In an unrelated-picture condition, the same six sets of words and pictures as in the identifying-picture condition were used, but the words and pictures on each page were rearranged so that each word was printed below a picture which was not an obvious associate of it. The word "coat" for example, was printed below a picture of a bunch of grapes.

Procedure. Each child was tested individually in an empty classroom in the school. The 18 pages of test materials (two sheets from each of the three difficulty levels under each of the three picture-word conditions) were administered to all of the 48 children, with each subject serving as his own control. The presentation order of the

18 sheets was individually randomized for each child. The testing session lasted for approximately 25 minutes.

The session began with a practice period during which each child was taught through modeling and instruction to read aloud the 15 words on two specially prepared practice pages quickly and accurately. He was then told that sometimes the experimenter would try "to trick him" by putting some pictures on the page, but that he should not pay any attention to them and should simply read the words aloud quickly and without error as he had done before. The child was then given two additional pages of practice with unrelated pictures and words on the pages. None of the words or pictures used in the practice session were the same as those used in the actual test materials. It was clear that all of the children understood that the pictures were there to distract them and that they should try to ignore them. As soon as the practice trials were completed, the test materials were introduced without a break in the procedures. On each trial, one of the 18 pages was placed face down on the table in front of the child and he was told to "get ready". The page was then turned face up and he was told to "begin".

A stopwatch was used to measure the time (to the nearest second) that it took each child to read the 15 words on a page. All sessions were tape recorded and reading errors were scored later from the tapes. An error was

scored when a child said a nonword, when he said a different word than the one on the page, or when he had to be told a word after 10 seconds had elapsed.

Design. There were three major independent variables: reading ability (good, normal, poor), word difficulty (easy, moderate, difficult), and picture-word condition (no pictures, identifying pictures, unrelated pictures). Thus the design was a 3 x 3 x 3 factorial design with one between- and two within-subjects variables.

Results

Initially, a 2 x 3 x 3 x 3 analysis of variance (ANOVA) was performed on both the time and errors measures with sex of child as an additional between-subjects variable. The results of this analysis showed that there were no sex differences (neither main effects nor interactions) on either measure ($F < 1$). Therefore, sex of child was not included in any subsequent analyses.

Reading Time

The results of the ANOVA on the reading time measure were clear-cut and significant. Table 3 summarizes the means and standard deviations for each reading-ability group at the three levels of difficulty. As one would expect there was a main effect of reading ability F (2,45) = 9.46 ($p < .01$). Better readers took less time to decode the words. There was also a main effect of the picture-word condition F (2,90) = 36.67 ($p < .01$), and an interaction of

reading ability with the picture-word treatments F (4,90) = 4.35 ($p < .01$). These effects are examined in more detail later in the subsections on Identifying Pictures and Unrelated Pictures.

Insert Table 3 about here

The word-difficulty variable also produced a main effect F (2,90) = 49.59 ($p < .01$), as well as a significant interaction with reading ability F (4,90) = 4.32 ($p < .01$). The reading times increased across the three levels of word difficulty, and for poor readers this increase in reading time was more marked.

Finally, there was an interaction between the picture-word conditions and the word-difficulty dimension F (4,180) = 5.14 ($p < .01$). This interaction resulted from the fact that while the unrelated pictures always produced interference relative to the no-picture condition, the identifying pictures slowed the children down when they were decoding the easiest words but facilitated their performance when they were reading more difficult words.

In order to elucidate the picture-word effects, difference scores were calculated between the two picture-word conditions and the no-picture control condition. These difference scores indicate the extent to which the pictures facilitated or interfered with speed of decoding.

Identifying Pictures. An ANOVA on the difference scores between reading times under the identifying-picture and no-picture conditions indicated that there was no main effect of reading ability ($F < 1$) but that there was a main effect on word difficulty F (2,90) = 8.13 ($p < .01$). The interaction between reading ability and word difficulty was not significant, F (4,90) = 1.51, $p > .10$.

It can be noted from Table 3 that for the reading time measure the size of the standard deviations tended to be proportional to the treatment means. This correlation also existed for the difference scores used in this analysis. Although the F test is known to be relatively little influenced by heterogeneity of variance when cell sizes are equal, the precaution was taken of performing a logarithmic transformation on the scores to normalize the distribution (as suggested by Myers, 1972). A reanalysis of the transformed data produced an identical pattern of results. There was no main effect of reading ability ($F < 1$); there was a main effect of word difficulty F (2,90) = 6.43, $p < .01$; and there was no significant reading ability x word difficulty interaction, F (4,90) = 1.79, $p > .10$.

As shown in Figure 1, the word-difficulty effect resulted from the fact that, when the words were easy the identifying pictures interfered with performance, and when words were more difficult the identifying pictures facilitated performance.

Insert Figure 1 about here

It can also be seen in Figure 1, that this effect appeared to be greater among the poor readers. To examine more closely the apparent relationship between reading ability and the influence of identifying pictures a Pearson correlation was computed. For each of the six different pages of words (two pages at each of the three levels of difficulty) a difference score was calculated between the reading times when no pictures were present and when the identifying pictures were present (NP-IP). Since any deviation from the no-picture baseline (either facilitation or interference) reflected an influence of the pictures, the absolute numbers were totaled for each child as an indication of their susceptibility to influence by identifying pictures. The zero-order correlation between this measure of susceptibility to influence by pictures and the Gates-MacGinitie Reading Comprehension test scores was $r(46) = -.54$, $p < .01$. The partial correlation, controlling for nonverbal IQ (IPAT scores) was $r(45) = -.52$, $p < .01$. Thus it is clear that the less skilled the reader the greater was the influence on reading time of identifying pictures above the words. Moreover, this inverse correlation was not accounted for by general nonverbal intelligence.

Unrelated Pictures. An additional ANOVA on the difference scores between reading times under the unrelated- and no-picture conditions showed that both reading ability F (2,45) = 4.07 ($p < .05$) and word difficulty F (2,90) = 4.43 ($p < .01$) produced significant main effects, and that there was no interaction between them ($F < 1$). To insure that the heterogeneity of variance which was evident in the difference scores here as well, had not radically affected the outcome of the ANOVA, the analysis was redone after a logarithmic transformation was performed on the scores. The ANOVA on the transformed scores resulted in essentially the same pattern of results. There were significant main effects of reading ability, F (2,45)= 3.70, $p < .05$, and of word difficulty, F (2,90)= 4.42, $p < .01$; and the reading ability x word difficulty interaction was not significant, F (4,90)= 1.11, $p > .10$.

Insert Figure 2 about here

As shown in Figure 2, unrelated pictures interfered with decoding, and the poor readers suffered substantially more interference from the unrelated pictures than both good and normal readers. The amount of variance accounted for by reading ability was examined following the same procedure as just described for the identifying-picture situation. Absolute difference scores were calculated between the

unrelated-picture and the no-picture decoding times (NP-UP) for each page of words. Again, Pearson correlations were computed to determine the degree to which the influence of unrelated pictures was a function of reading ability. The zero order correlation between the difference scores and Gates-MacGinite Reading Comprehension scores was $r(46) = -.62$, $p < .01$. The partial correlation controlling for nonverbal IQ was $r(45) = -.52$, $p < .01$. Clearly, the less-skilled readers were more vulnerable to influence by the unrelated pictures and nonverbal intelligence factors were not primarily responsible for this inverse correlation.

The main effect of word difficulty (shown in Figure 2) resulted from the fact that there was less interference on the moderate than on the relatively easier and more difficult words. Without further research this effect is not easily interpretable. The finding may have something to do with the particular picture-word combinations used in the moderate condition. It cannot be inferred from these data that, in general, words of moderate difficulty produce less interference than easy and difficult ones. In this experiment, word difficulty was clearly relative to the reading ability of the child. By examining the mean reading times in Table 3, it can be seen, for example, that in the no-picture baseline condition, the normal and poor readers found the moderate words somewhat more difficult than the good readers found the most difficult words.

Individual Differences. In Figure 3 the amount of interference caused by the unrelated pictures is plotted for the subjects in the three reading-ability groups. It is evident from the graph that all of the good readers and all but two of the normal readers showed relatively little interference from the pictures. The poor readers, however, were more variable in the amount of interference they suffered in the presence of the unrelated pictures. Half of the poor readers (8 children) were no more susceptible to interference than were the good and normal readers, but the other half of the poor readers were more interference-prone than all of the good readers and nearly all of the normal readers.

Insert Figure 3 about here

In order to determine whether the same children tended to pay more attention to the pictures in both the identifying and in the unrelated picture conditions, a Pearson correlation was performed on the NP-IP and NP-UP absolute difference scores. The correlation coefficient of $r(46) = .50$, $p < .01$, indicates that there is some consistency across materials. Children whose performance is influenced by identifying pictures are also more susceptible to interference by unrelated pictures.

Decoding Errors

There were very few decoding errors either with or without pictures. The mean numbers of decoding errors (out of a possible 30) in the no-picture condition at the three difficulty levels were respectively: Good readers .31, .75, .63; Normal readers .63, 1.00, .75; Poor readers .94, 1.00, 3.06. The difference in the numbers of errors children made in the no-picture and in the two picture-word conditions were examined to further investigate the facilitative and interfering effects of pictures.

Identifying Pictures. When the decoding errors scores under the no-picture condition were subtracted from the identifying-picture condition, a measure of the effect of the identifying pictures was obtained for each child. An ANOVA on these scores showed that there was a main effect of reading ability F (2,45) = 4.40 ($p < .05$) and an interaction between reading ability and word difficulty F (4,90) = 7.93 ($p < .01$). The identifying pictures did not influence good and normal readers' decoding accuracy. Poor readers, however, made fewer decoding errors when there were identifying pictures above the most difficult words. It should be noted, however, that decoding accuracy could not improve very much for the better readers at any level of word difficulty because it was almost perfect already. For the poorer readers also, there was less room for improvement at the easier levels of word difficulty. In view of this

floor effect, any conclusions based on the decoding errors data are necessarily limited.

Unrelated Pictures. The difference scores between the no-picture condition and the unrelated-picture condition on decoding errors were also analyzed. The only significant effect of that ANOVA was a reading ability x word difficulty interaction F (4,90) = 3.61 ($p < .05$). Although this interaction was statistically significant, the absolute size of the effect on decoding accuracy was very small. Moreover, the result may again simply reflect the floor effect on decoding errors.

Discussion

The child's task under all conditions was simply to read a set of words aloud with speed and accuracy. A baseline for each child's performance was provided by his reading time and errors scores on each set of words under the no-picture control condition. When pictures were placed on the page, if the child read either faster or slower than he did in the baseline condition, then that change was clearly attributable to the presence of the pictures.

Difficulty of Decoding. If poor readers are more susceptible than good readers to influence by pictures simply as a function of the relatively greater difficulty of the decoding task for them, then it would have been expected that the performance of poor readers would be less influenced by pictures when they were decoding words which

were easier for them, and that more skilled readers might be more influenced by pictures when they were decoding words which were relatively more difficult. In terms of the theory of automaticity (LaBerge & Samuels, 1974), if the decoding of the words could be performed without attention, then the processing of additional information (the pictures) could take place simultaneously with little or no performance decrement. The results of the study could not, however, be acccunted for by an automaticity interpretation. The deccding performance of the poor readers was considerably influenced by the pictures at all levels of word difficulty. That of good and normal readers was more, not less (as the automaticity view would predict), affected by pictures at the easiest level of word difficulty.

In view of the fact that the differences among reading-ability groups in susceptibility to influence by pictures cannot be accounted for by an automaticity interpretation, it seems most reasonable to attribute reading-speed increases and decreases in the presence of pictures to diversion of attention from the decoding task. When the pictures on the page identified the words printed below them, then paying attention to the pictures might be expected to make the task easier if the child had some uncertainty about the words he was decoding (indeed, he could simply name the pictures), but might make performance less efficient if the words were already very familiar to

him. When the pictures were unrelated to the words printed below them then it might be expected that processing the pictures would have a generally debilitating effect on efficiency of decoding at all levels of difficulty. This, in fact, was the pattern of results obtained in this research.

Individual Differences. Under one condition or another the good, normal, and poor readers were all influenced in their decoding performances by the presence of pictures. The degree of this effect was, however, clearly different depending upon the child's level of reading skill. Good and normal readers were less susceptible to influence by pictures than were poor readers. Moreover, the patterns of performance of good and normal readers were quite similar to each other in the various conditions and differed from those of poor readers. The poor readers paid more attention to the pictures in all conditions. In the identifying-picture condition, poor readers were debilitated in their reading performance when they were decoding easy words and were facilitated while reading the more difficult words. In the unrelated-picture condition, the pictures interfered with the poor readers' decoding at all levels of word difficulty.

Reading problems undoubtedly have many and varied origins. On the basis of the results of this experiment, it is clear that a significant proportion of children with reading difficulties are less able to resist being

influenced by adjunct pictures while reading than are more proficient readers. Since the pictures in their primers and other school books are rarely placed above the words they identify, children who have a tendency to refer to nearby pictures when they are unsure of words will almost invariably be misled.

Thus, although the adjunct pictures in children's early readers are surely intended as an aid to reading, it is clear from the present research that for some individuals such pictures may well seriously interfere with reading performance. Indeed, children who are especially susceptible to visual distraction in a reading situation may actually be "reading failures" as a result of the presence of adjunct pictures in their primers. Given this possibility, perhaps, on entering school, children should be screened for susceptibility to distraction by pictures and their primers should be assigned accordingly. However, before any drastic measures are taken, other picture research employing reading tasks which more closely resemble "normal" reading should certainly be undertaken.

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Footnote

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TABLE 1

Relative Difficulty Level of Words

Based on Reaction Times of 74 Third Graders

EASY Words				MODERATE Words				DIFFICULT Words			
	$\bar{X}$ Latency	S.D.	Errors		$\bar{X}$ Latency	S.D.	Errors		$\bar{X}$ Latency	S.D.	Errors
boat	1.0691	0.2064	1	ring	1.1463	0.2464	1	mask	1.2825	0.3701	0
sun	1.0766	0.1530	0	ham	1.1690	0.2961	0	train	1.2887	0.3572	0
egg	1.0944	0.1779	0	star	1.1742	0.2992	2	chair	1.2282	0.3169	0
jet	1.1069	0.2303	1	log	1.1384	0.2009	1	foot	1.2493	0.3816	4
cat	1.0969	0.2279	0	cup	1.1494	0.2783	0	bug	1.2600	0.4625	1
man	1.0488	0.1584	0	cake	1.1454	0.2765	0	goat	1.2876	0.3663	2
dog	1.0564	0.1920	0	shoe	1.1578	0.2729	0	gate	1.2502	0.3912	2
bed	1.0302	0.1957	0	head	1.1551	0.2897	0	rake	1.2553	0.3978	3
rock	1.0793	0.1736	1	pie	1.1386	0.3118	2	goose	1.3005	0.2878	2
milk	1.0954	0.1988	0	tent	1.1595	0.2617	1	spoon	1.2655	0.2682	0
boy	1.0701	0.2643	0	hen	1.1710	0.2864	0	pig	1.2458	0.3031	0
book	1.0493	0.1814	2	cow	1.1459	0.2164	2	ball	1.2406	0.3420	1
hat	1.0402	0.1935	0	fire	1.1412	0.1840	0	drum	1.2718	0.4207	3
box	1.0932	0.1974	0	eye	1.1416	0.2918	0	bread	1.3011	0.4598	2
fish	1.0967	0.2037	0	doll	1.1449	0.2857	0	frog	1.2627	0.3445	0
moon	1.1348	0.2797	0	bus	1.2117	0.2523	0	chain	1.4342	0.4715	5
fox	1.1014	0.2270	0	lamb	1.2185	0.3632	4	sled	1.4027	0.4673	1
car	1.0952	0.2278	0	pool	1.2127	0.2207	3	bowl	1.5304	0.4976	5
bell	1.1201	0.2849	0	dish	1.1850	0.3167	0	grapes	1.3242	0.3995	3
leaf	1.1294	0.2504	0	nails	1.2042	0.2193	2	fence	1.3717	0.4846	6
tree	1.0998	0.2412	0	key	1.1926	0.3351	1	church	1.3132	0.3341	3
bird	1.1191	0.3178	0	shell	1.1952	0.2544	2	plate	1.3947	0.4949	4
ear	1.1490	0.2425	0	corn	1.2224	0.3046	0	kite	1.3689	0.4337	5
horse	1.1299	0.2759	0	duck	1.1781	0.3745	0	roof	1.3417	0.4281	1
girl	1.1185	0.1566	0	leg	1.2126	0.3242	1	saw	1.3985	0.4524	0
mouse	1.1309	0.2242	0	desk	1.2430	0.3626	1	tire	1.4266	0.5072	6
door	1.0885	0.1776	0	shirt	1.2217	0.2919	1	clown	1.3265	0.4209	1
bike	1.1339	0.2471	0	dress	1.2089	0.3023	1	skate	1.3633	0.4720	1
ship	1.1219	0.2053	0	truck	1.1759	0.2905	0	ghost	1.4872	0.5452	1
cap	1.1317	0.3011	2	frog	1.1954	0.3570	0	coat	1.3095	0.4234	1

Table 2

Means and Standard Deviations on Age, IQ, and Reading for the Good, Normal, and Poor Reader Groups

Groups	Chronological Age (in months)	IPAT IQ	Gates-MacGinitie Reading Comprehension
Good Readers (N = 16)	M = 104.3 SD = 3.7	M = 111.7 SD = 8.4	M = 58.7 SD = 4.5
Normal Readers (N = 16)	M = 100.9 SD = 3.5	M = 111.8 SD = 6.0	M = 51.3 SD = 2.7
Poor Readers (N = 16)	M = 103.2 SD = 3.6	M = 110.4 SD = 10.2	M = 45.1 SD = 3.6

Table 3

Mean Time (sec) to Read 30 Words at each Difficulty Level

(Standard Deviations are in Parentheses)

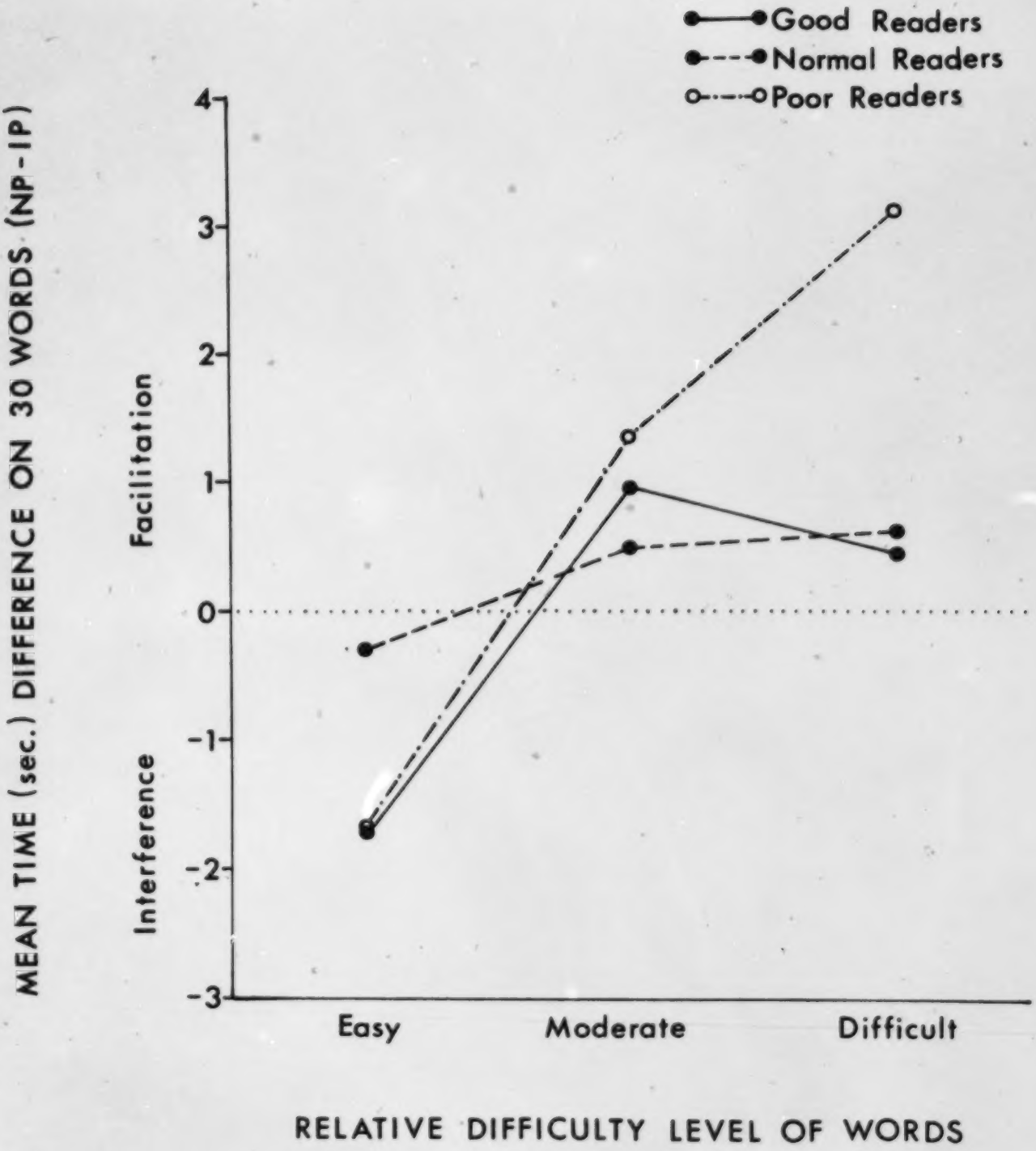
	Picture-Word Condition		
Groups	No Pictures	Identifying Pictures	Unrelated Pictures
Good Readers			
Easy	14.3 (2.17)	16.0 (2.76)	18.0 (4.08)
Moderate	17.3 (2.39)	16.4 (2.48)	17.8 (3.35)
Difficult	17.5 (3.69)	17.1 (3.08)	20.3 (4.40)
Normal Readers			
Easy	17.1 (3.94)	17.5 (4.02)	21.1 (4.69)
Moderate	19.4 (4.68)	18.9 (3.29)	21.2 (5.68)
Difficult	20.4 (6.31)	19.9 (4.55)	24.4 (8.65)
Poor Readers			
Easy	18.7 (2.86)	20.4 (3.91)	25.8 (7.93)
Moderate	22.5 (5.25)	21.2 (4.94)	28.5 (11.88)
Difficult	26.3 (8.37)	23.2 (4.26)	32.6 (12.57)

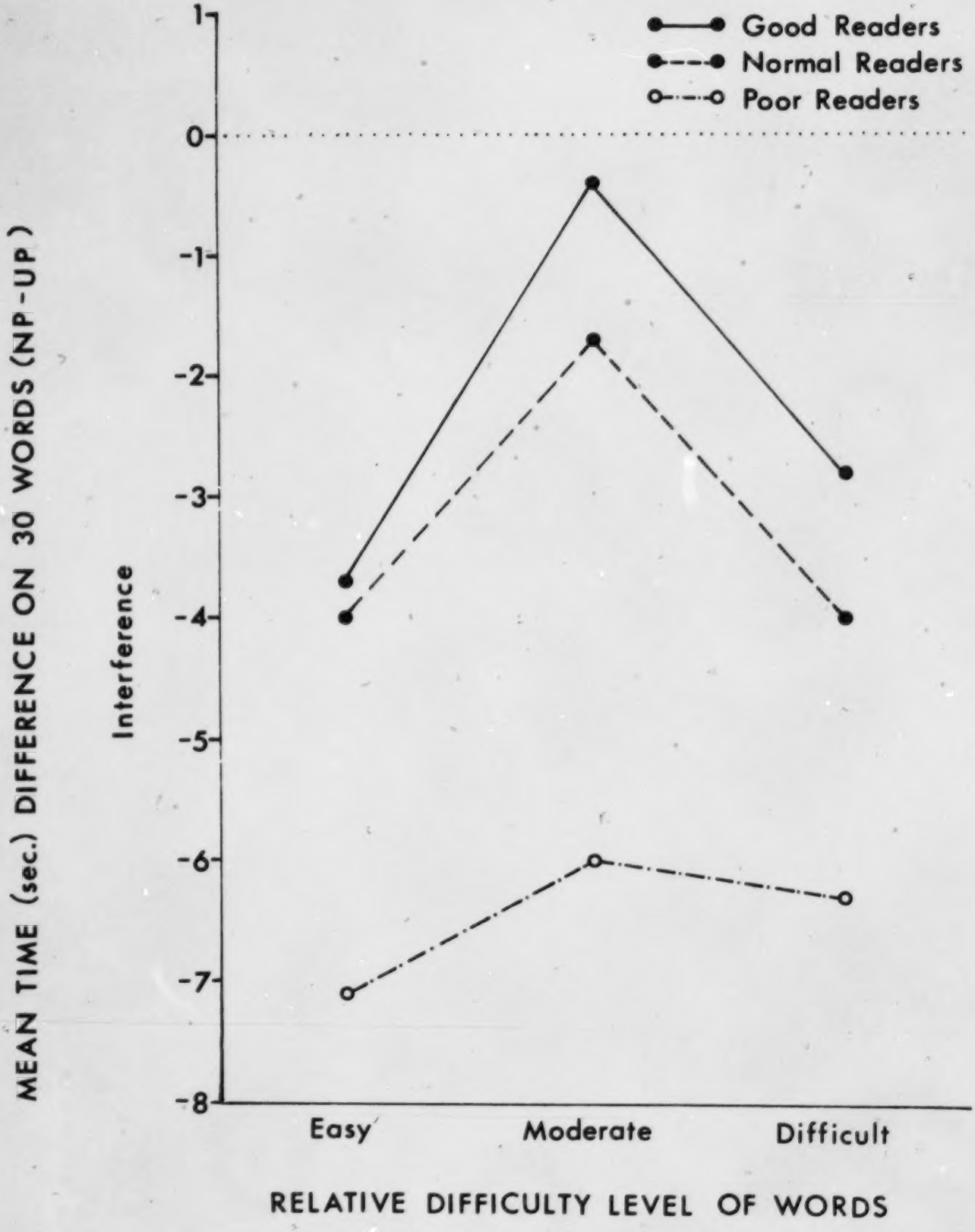
Figure Captions

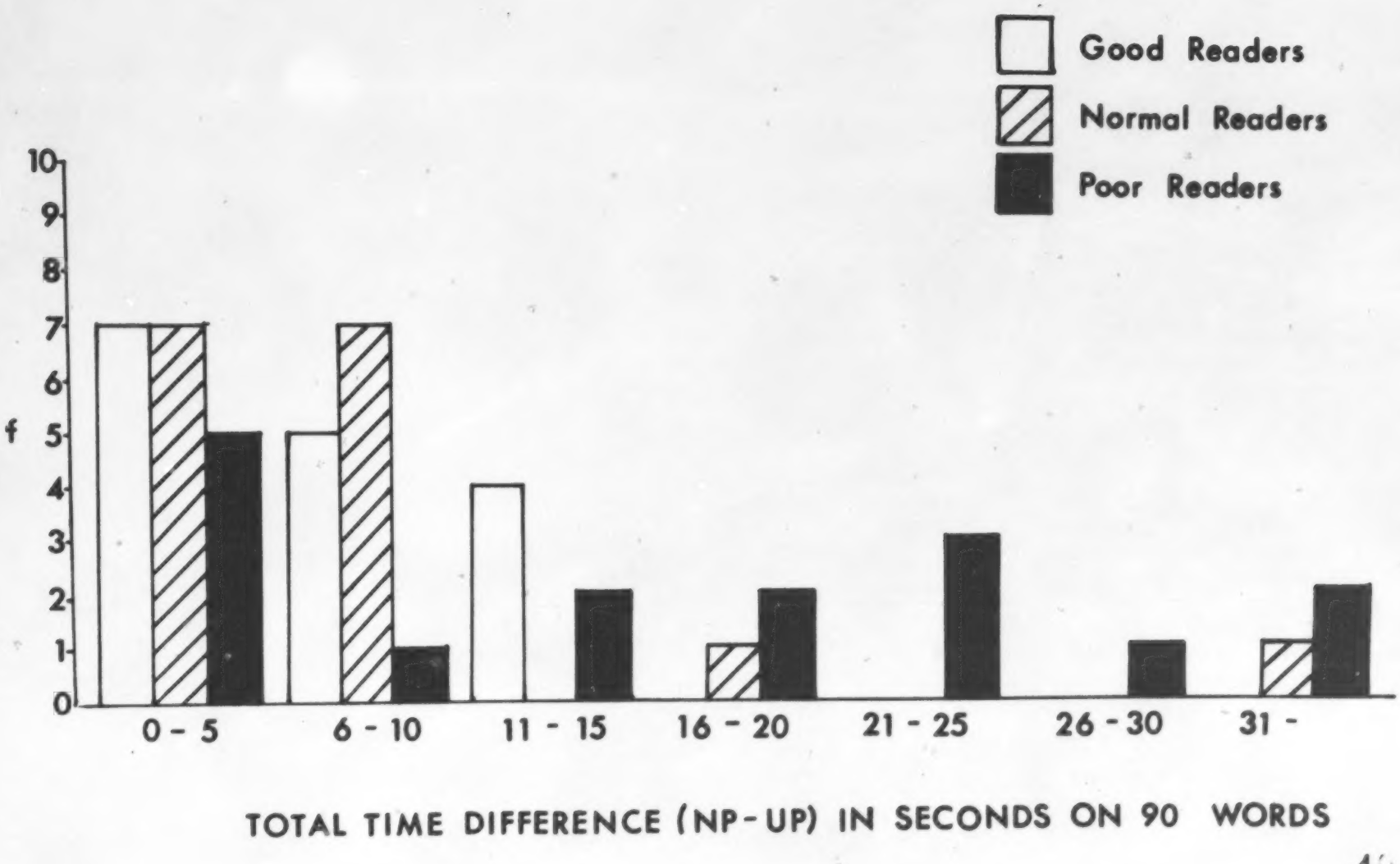
Figure 1. Mean difference in reading time between the No-Picture condition (NP) and the Identifying-Picture condition (IP).

Figure 2. Mean difference in reading time between the No-Picture condition (NP) and the Unrelated-Picture condition (UP).

Figure 3. Frequency distribution of picture-word interference scores (NP-UP) for Good, Normal, and Poor readers.


Good Readers
Normal Readers
Poor Readers
MEAN TIME (sec.) DIFFERENCE ON 30 WORDS (NP-IP)
Facilitation
Interference
4
3
2
1
0
-1
-2
-3
Easy
Moderate
Difficult
RELATIVE DIFFICULTY LEVEL OF WORDS


Good Readers
Normal Readers
Poor Readers
1
0
-1
-2
-3
-4
-5
-6
-7
-8
Interference
MEAN TIME (sec.) DIFFERENCE ON 30 WORDS (NP-UP)
Easy
Moderate
Difficult
RELATIVE DIFFICULTY LEVEL OF WORDS


Good Readers
Normal Readers
Poor Readers
f
10
9
8
7
6
5
4
3
2
1
0
0 - 5
6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 -
TOTAL TIME DIFFERENCE (NP-UP) IN SECONDS ON 90 WORDS